

**Absorbent Member with Improved Fluid Handling Agent**

Maurizio Tamburro

Nicola D'Alesio

Antonella Pesce

Achille Di Cintio

Giovanni Carlucci

Adelia Tordone

**FIELD OF THE INVENTION**

The present invention relates to an absorbent member comprising fine particles of chitosan material, in particular water-soluble chitosan salt, for improved fluid retention and leakage prevention, and a process for making such an absorbent member.

**BACKGROUND OF THE INVENTION**

Webs, particularly fibrous structures for absorbing fluids, are manufactured for many uses. They are for example incorporated into absorbent articles such as disposable diapers, incontinent pads, sanitary napkins and panty liners as fluid absorption and/or fluid transmission and/or diffusion elements, especially as absorbent cores that are intended to absorb and retain body fluids.

The primary focus of absorbent articles is the ability of those articles to absorb and retain fluids. Indeed there is a continuous trend to be noted towards further increasing the fluid retention and leakage prevention characteristics of absorbent articles. However, presently available absorbent articles are still not completely satisfactory in this respect, since the occurrence of fluid leakage, e.g. through the topsheet or along the peripheral edge, is still a problem.

Besides those primary characteristics, other features like comfort are increasingly important for users of absorbent articles. To satisfy this need so-called breathable absorbent articles, offering gas and vapour exchange through the backsheet of the articles, have been developed and commercialised. However, breathable articles suffer from negatives like occurrence of undesired body fluid leakage especially through the backsheet.

Attempts have been made to overcome these recurring problems, by for example increasing the amount of superabsorbent materials or using coagulants, see for example EP-A-906 074. However, these solutions are not completely satisfactory. It has been observed that despite the extensive use of superabsorbents, such as absorbent gelling materials, in absorbent articles in  
5 many incidents there was free fluid, especially between the backsheet and the absorbent core in used absorbent articles, which led to leakage through the topsheet or along the peripheral edge of the article. In the case of so-called breathable absorbent articles, the presence of this free fluid might additionally cause leakage through the breathable backsheet. Thus, there still exists the need for further improved absorbent articles, in which the generation of such free fluids and the  
10 leakage resulting therefrom is reliably inhibited.

It is therefore an object of the present invention to provide an absorbent article comprising an absorbent member offering improved fluid retention by preventing or at least reducing the occurrence of free fluids and/or immobilizing such free fluids. More particularly, the present  
15 invention seeks to provide absorbent articles having an absorbent member with improved fluid retention characteristics, resulting in reduced leakage.

It is a further object of the present invention to provide such an absorbent member in a particularly cost efficient way by using only a very low amount of active material.

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The above-mentioned objects have now surprisingly been met by providing an absorbent member, in particular a substantially hydrophilic one, comprising at least one region with particles of chitosan material, in particular substantially water-soluble chitosan salt, having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than about 300  $\mu\text{m}$ .

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It has been found that by selecting very fine particles of chitosan material, having a particles size distribution with a mean diameter  $D(v,0.9)$  of not more than about 300  $\mu\text{m}$ , it is possible to obtain a high active surface of the chitosan material while using a reduced amount of the chitosan material therefore. It has furthermore been found that by selecting a substantially water-soluble  
30 chitosan salt further benefits in terms of increased gelification performance especially towards blood, menses and the like can be achieved. Without to be bound by theory it is speculated that water-soluble chitosan salts are able to come into much more intimate contact with fluids to be gelified by dissolving in such fluids compared to non-soluble chitosan materials, which are only able to gelify fluids by surface interaction. By the use of such fine particles of chitosan material,

especially substantially water-soluble chitosan salts, in a certain region of an absorbent article it is ensured that free fluid in said region are immobilized by gelification and hence leakage is reduced or even prevented.

5 In a preferred embodiment, the region with the fine particles of chitosan material also optimises the prevention of fluid leakage in breathable absorbent articles. It has been found that by immobilizing occurring free fluids these fluids are prevented from reaching the parts of the absorbent article between the absorbent core and the breathable backsheet. By this, the probability of leakage through the breathable backsheet is significantly reduced.

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In its broadest embodiment, the present invention also encompasses a process of making an absorbent member, wherein a solution or dispersion of chitosan material, in particular a substantially water-soluble chitosan salt, is applied onto a precursor web in the form of a spray of droplets, said droplets having a droplet size distribution with a mean diameter  $D(v,0.9)$  of not  
15 more than 1500  $\mu\text{m}$ . An advantage of this process is that a region of particles of chitosan materials having a particles size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  is provided on the surface of the precursor web, which translates in outstanding fluid retention / leakage prevention towards fluids while requiring a lower amount of chitosan material. Indeed, by applying a solution or dispersion of chitosan materials onto the precursor web in the  
20 form of a spray of small droplets as defined herein, a higher coverage can be achieved with the same amount of solution/dispersion as compared to applying the same solution or dispersion in the form of a spray of droplets with larger droplets. Furthermore, applying the solution or dispersion onto the precursor web as small droplets also translates into limited wetting of the surface and thus in better processability of the precursor web and subsequent disposable  
25 absorbent articles comprising the resulting absorbent member.

#### PRIOR ART BACKGROUND

The use of chitosan in absorbent articles has been discussed in several prior art documents. EP-B-  
30 627,225 discloses the preparation of chitosan compounds with improved absorption characteristics and suggests their usage in sanitary hygiene articles. DE 19,913,478 discloses a breast pad comprising chitosan for improved absorption of fat-containing liquids, such as milk. WO 99/61079 and WO 99/32697 disclose the use of chitosan coatings onto hydrophobic substrates for providing antimicrobial absorbent structures, e.g. nonwovens. EP-B-393,825

teaches the utilization of chitosan salts in absorbent products. A structure formed by a cellulose web containing chitosan for water absorbance and starch as the binder for the structure is disclosed.

- 5 None of the cited prior art discloses an hydrophilic absorbent member comprising at least one region with very fine particles of chitosan material, in particular substantially water-soluble chitosan salt, let alone the specific benefits in terms of fluid retention and leakage prevention at reduced consumption of chitosan material associated therewith.

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#### SUMMARY OF THE INVENTION

- The present invention relates to an absorbent member, in particular a substantially hydrophilic one, for use in absorbent articles, said member comprising at least one region with particles of chitosan material, in particular substantially water-soluble chitosan salts, having a particle size  
15 distribution with a mean diameter  $D(v,0.9)$  of not more than about 300  $\mu\text{m}$ . Said absorbent member is suggested to be used as absorbent core, secondary topsheet or secondary backsheet in absorbent articles of personal hygiene.

- The present invention furthermore encompasses a process for making an absorbent member  
20 comprising at least one region with particles of chitosan material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than about 300  $\mu\text{m}$ . The method comprises the essential steps of forming a precursor web, applying a solution or dispersion of chitosan material onto the precursor web and drying the precursor web, whereby said solution or dispersion is applied as a spray of droplets having a droplet size distribution with a mean  
25 diameter  $D(v,0.9)$  of not more than about 1500  $\mu\text{m}$ .

#### BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1 illustrates one possible configuration of the process for making the absorbent member  
30 according to the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

### Definitions

- 5 The term 'absorbent article' is used herein in a very broad sense including any article able to receive and/or absorb and/or contain and/or retain fluids and/or exudates, especially bodily fluids/bodily exudates. The absorbent article, which is referred to in the present invention typically comprises a fluid pervious topsheet, a fluid impervious backsheet that is preferably water vapour and/or gas pervious and an absorbent core comprised there between. Particularly preferred absorbent articles in the context of the present invention are disposable absorbent
- 10 articles. Typical disposable absorbent articles according to the present invention are diapers, surgical and wound dressings and perspiration pads, incontinence pads, and preferably absorbent articles for feminine hygiene like sanitary napkins, panty liners, tampons, interlabial devices or the like.
- 15 The term 'disposable' is used herein to describe articles, which are not intended to be laundered or otherwise restored or reused as an article (i.e. they are intended to be discarded after a single use and preferably to be recycled, composted or otherwise disposed of in an environmentally compatible manner).
- 20 The term 'use', as used herein, refers to the period of time that starts when the absorbent article is actually put in contact with the anatomy of the user.

### Absorbent member for use in absorbent articles

- 25 The term 'absorbent member' is used herein to describe an absorbent web, particularly a substantially hydrophilic one, suitable for use in absorbent articles. The absorbent member comprises two surfaces aligned substantially opposite to each other. The first and the second surface are spaced apart from each other by the thickness dimension of the absorbent member. The absorbent member comprises at least one region with particles of chitosan material, in
- 30 particular substantially water-soluble chitosan salt, having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than about 300  $\mu\text{m}$ , and optionally a latex coating. The absorbent member of the present invention is in particular substantially hydrophilic to ensure optimum fluid absorbency and -retention characteristics. As used herein, 'hydrophilic' refers to a material having a contact angle of water in air of less than 90 degrees, whereas the term 'hydrophobic'

herein refers to a material having a contact angle of water in air of 90 degrees or greater. The absorbent member for use herein typically has significant internal void space in the form of pores, holes, apertures, interstitial space between fibres and the like. Examples of absorbent members for use in the present invention are fibrous materials, such as nonwovens or fabrics, comprising natural or synthetic fibres or mixtures thereof, or apertured polymeric films or foam materials. Indeed, the absorbent member for use in the present invention can be made of any of a variety of fibres, including a blend or admixture. The fibres may be cellulosic, modified cellulosic, or hydrophilic synthetic and include such fibres as wood pulp, rayon, cotton, cellulose acetate, polyester, nylon and the like. The absorbent member can be made according to any suitable method known for this purpose in the art. Fibrous absorbent members according to the present invention can be made by appropriate processes such as dry laying and in particular air laying, melt blowing or spunbonding. Film-like or foam-like absorbent members according to the present invention are made by processes suitable for such purposes. Highly preferred absorbent members for use herein are hydrophilic fibrous webs. A absorbent member comprising hydrophilic fibres like for example cellulosic fibres such as wood pulp fibres is particularly useful in such products as sanitary napkins, disposable diapers or wipes because the hydrophilic fibres are liquid absorbent and therefore enhance the overall absorbency of the absorbent member. Preferably, absorbent members for use herein can be made of a blend of cellulosic and hydrophilic synthetic fibres, typically comprising about 65% to 95% by weight of cellulosic fibres and more preferably up to about 20% by weight of the hydrophilic synthetic fibres. The hydrophilic synthetic fibres, which can be provided in any length including staple length, can improve the strength of the absorbent member. Hydrophobic fibres or films, such as fibres or films made of polyethylene or polypropylene, may also be used in the absorbent member herein provided they are treated by e.g. surfactants to make them hydrophilic, in order not to decrease the absorbent capacity of the preferred absorbent member. In a preferred embodiment the absorbent member for use herein is a dry laid, preferably an air laid fibrous web. 'Dry laying' and more specifically, 'air laying' processes are widely used to produce webs from dry fibres, which can in turn be used e.g. as webs for absorbing fluids. Particularly, dry laying refers to e.g. carding or air laying. Carding refers to the formation of carded absorbent members, i.e. absorbent members in which the fibres are oriented (carded) in a given direction, whereas the air laying process refers to the formation of absorbent members with a completely random fibre orientation; the properties of such air laid absorbent members are therefore somewhat isotropic. The absorbent members produced by dry laying processes are soft, flexible and porous and are particularly suitable for use as liquid absorbent members in absorbent articles, such as disposable

diapers, sanitary napkins, incontinent pads and wipes. The absorbent member of the present invention can be used as absorbent core or so-called secondary topsheet or secondary backsheet in absorbent articles. The absorbent member of the present invention reduces or even prevents leakage through the topsheet and along the peripheral edge of such absorbent articles due to immobilization of body fluids by gelification.

‘Secondary topsheet’ as used herein means layers in absorbent articles, which are located between the absorbent core and the topsheet of the article. Respectively, ‘secondary backsheet’ as used herein means layers in absorbent articles, which are located between the absorbent core and the backsheet of the article.

In a preferred embodiment, the absorbent member of the present invention is used in breathable absorbent articles. It is believed that the particles of the chitosan material, in particular the substantially water-soluble chitosan salt, act as a fluid immobiliser, which by gelification hinders or even prevents body fluids from approaching at the breathable backsheet.

The absorbent member of the present invention comprises as essential at least one region with particles of chitosan material, in particular substantially water-soluble chitosan salt, having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than about 300  $\mu\text{m}$ .

‘Chitosan material’ as used herein includes chitosan, chitosan salts, modified chitosans and cross-linked chitosans. Chitosan is a partially or fully deacetylated form of chitin, a naturally occurring polysaccharide. Indeed, chitosan is an aminopolysaccharide usually prepared by deacetylation of chitin (poly-beta(1,4)-N-acetyl-D-glucosamine).

Chitosan is not a single, definite chemical entity but varies in composition depending on the conditions of manufacture. It may be equally defined as chitin sufficiently deacetylated to form soluble amine salts. Chitosan is the beta-(1,4)-polysaccharide of D-glucosamine and is structurally similar to cellulose, except that the C-2 hydroxyl group in cellulose is substituted with a primary amine group in chitosan. The large number of free amine groups makes chitosan a polymeric weak base. Solutions of chitosan are generally highly viscous, resembling those of natural gums.

The chitosan used herein is suitably in relatively pure form. Methods for the manufacture of pure chitosan are well known. Generally, chitin is milled into a powder and demineralised with an organic acid such as acetic acid. Proteins and lipids are then removed by treatment with a base, such as sodium hydroxide, followed by chitin deacetylation by treatment with concentrated base, such as 40 percent sodium hydroxide. The chitosan formed is washed with water until the desired pH is reached.

The properties of chitosan relate to its polyelectrolyte and polymeric carbohydrate character. Thus, it is generally insoluble in water, in alkaline solutions at pH levels above about 7, or in hydrophobic organic solvents. It generally dissolves readily in dilute aqueous solutions of organic acids such as formic, acetic, tartaric, glycolic, lactic and citric acids and also in dilute aqueous solutions of mineral acids, except, for example, sulphuric acid. In general, the amount of acid required to dissolve chitosan is approximately stoichiometric with the amino groups. Since the  $pK_a$  for the amino groups present in chitosan is between 6.0 and 7.0, they can be protonated in very dilute acids or even close to neutral conditions, rendering a cationic nature to this biopolymer. This cationic nature is the basis of many of the benefits of chitosan. Indeed, chitosan material can be considered as a linear polyelectrolyte with a high charge density which can interact with negatively charged surfaces, like proteins (e.g. by interfering with the proteinic wall construction of microorganisms, thereby acting as an antimicrobial agent and/or by reacting with the proteins present in bodily fluid, like menses, thereby acting as a gelifying agent for such fluid).

Without wishing to be bound by any theory, it is believed that chitosan material retains electrolyte-containing fluids like body fluids by multiple mechanisms.

One mechanism is conventional absorption by incorporation of the water dipole molecules into the structure. As the quaternary ammonium groups, being positively charged, are distracting each other, molecular cavities exist, in which water molecules can penetrate. By the penetration of dipole molecules, like water, these cavities can be widened by swelling and thereby generating even more space for further water molecules. This mechanism can be continued until the limits of molecular tension are reached.

The second mechanism of binding electrolyte-containing fluids, like body fluids, by chitosan material is gelification. Chitosan material acts electrostatically on nearby negatively charged

molecules and thereby holds them in its circumference. The positively charged cationic groups (e.g., quaternary ammonium groups) of the chitosan material will interact with negatively charged anionic function-bearing molecules present in bodily fluids, like for example the carboxylic groups of proteins. This will result in the formation of a three-dimensional network between the chitosan material and such molecules with anionic groups (gelification of the bodily fluids). This gelification will further entrap other molecules present in body fluids (like lipids, acids). Due to the gelification properties of the chitosan material with respect to electrolyte-containing fluids, a liquid barrier is generated when the chitosan material is wetted by such fluids.

- 10 Preferred chitosan materials for use herein have an average degree of deacetylation (D.A.) of more than 70%, preferably from 80% to about 100%. The degree of deacetylation refers to the percentage of the amine groups that are deacetylated. This characteristic is directly related to the hydrogen bonding existing in this biopolymer, affecting its structure, solubility and ultimately its reactivity. The degree of deacetylation can be determined by titration, dye adsorption, UV/vis, IR and NMR spectroscopy. The degree of deacetylation will influence the cationic properties of chitosan. By increasing the degree of deacetylation the cationic character of the chitosan material will increase and thus also its gelifying abilities.

- 20 Suitable chitosan materials to use herein include substantially water-soluble chitosan. As used herein, a material will be considered water-soluble when it substantially dissolves in excess water to form a clear and stable solution, thereby, losing its initially particulate form and becoming essentially molecularly dispersed throughout the water solution. Preferred chitosan materials for use herein are water soluble, i.e. at least 1 gram and preferably at least 3 gram of the chitosan materials are soluble in 100 grams of water at 25°C and one atmosphere. By 'solubility' of a given compound it is to be understood herein the amount of said compound solubilised in deionised water at 25°C and one atmosphere in absence of a precipitate. Generally, the water-soluble chitosan materials will be free from a higher degree of crosslinking, as crosslinking tends to render the chitosan materials water insoluble.

- 30 Chitosan materials may generally have a wide range of molecular weights. Chitosan materials with a wide range of molecular weights are suitable for use in the present invention. Typically, chitosan materials for use herein have a molecular weight ranging from 1,000 to 10,000,000 grams per gram moles and more preferably from 2,000 to 1,000,000. Molecular weight means average molecular weight. Methods for determining the average molecular weight of chitosan

materials are known to those skilled in the art. Typical methods include for example light scattering, intrinsic viscosity and gel permeation chromatography. It is generally most convenient to express the molecular weight of a chitosan material in terms of its viscosity in a 1.0 weight percent aqueous solution at 25°C with a Brookfield viscometer. It is common to indirectly  
5 measure the viscosity of the chitosan material by measuring the viscosity of a corresponding chitosan salt, such as by using a 1.0 weight percent acetic acid aqueous solution. Chitosan materials suitable for use in the present invention will suitably have a viscosity in a 1.0 weight-% aqueous solution at 25°C of from about 10 mPa·s (10 centipoise) to about 100,000 mPa·s (100,000 centipoise), more suitably from about 30 mPa·s (30 centipoise) to about 10,000 mPa·s  
10 (10,000 centipoise), even more suitably 7000 mPa·s (7000 centipoise).

The pH of the chitosan materials depends on their preparation. Preferred chitosan materials for use herein have an acidic pH, typically in the range of 3 to 7, preferably about 5. By pH of the chitosan material, it is meant herein the pH of a 1% chitosan material solution (1 gram of  
15 chitosan material dissolved in 100 grams of distilled water) measured by a pH-meter. By using a more acidic pH, the cationic character of the chitosan materials will be increased and thus their gelifying abilities. However, too high acidity is detrimental to skin safety. Thus it is highly preferred herein to use chitosan materials with a pH of about 5, thereby delivering the best compromise between fluid handling properties on one side and skin compatibility on the other  
20 side.

Particularly preferred chitosan materials for use herein are chitosan salts, especially substantially water-soluble chitosan salts. A variety of acids can be used for forming water-soluble chitosan salts. Suitable acids for use are soluble in water or partially soluble in water, are sufficiently  
25 acidic to form the ammonium salt of chitosan and yet not sufficiently acidic to cause hydrolysis of chitosan and are present in amount sufficient to protonate the reactive sites of chitosan.

Preferred acids can be represented by the formula:

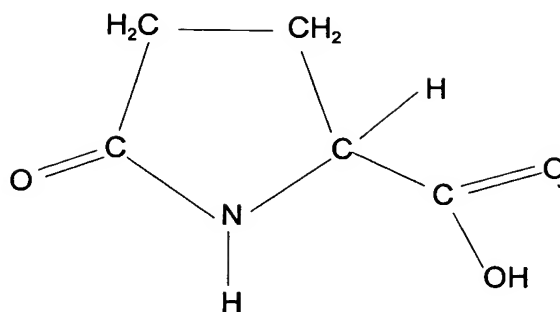


wherein n has a value of 1 to 3 and R represents a mono- or divalent organic radical composed of carbon, hydrogen and optionally at least one of oxygen, nitrogen and sulphur or simply R is an hydrogen atom. Preferred acids are the mono- and dicarboxylic acids composed of carbon,

hydrogen, oxygen and nitrogen (also called hereinafter amino acids). Such acids are highly desired herein as they are biologically acceptable for use against or in proximity to the human body. Illustrative acids, in addition to those previously mentioned include, among others, are citric acid, formic acid, acetic acid, N-acetylglycine, acetylsalicylic acid, fumaric acid, glycolic acid, iminodiacetic acid, itaconic acid, lactic acid, maleic acid, malic acid, nicotinic acid, 2-pyrrolidone-5-carboxylic acid, salicylic acid, succinamic acid, succinic acid, ascorbic acid, aspartic acid, glutamic acid, glutaric acid, malonic acid, pyruvic acid, sulfonyldiacetic acid, benzoic acid, epoxysuccinic acid, adipic acid, thiodiacetic acid and thioglycolic acid. Any chitosan salts formed from the reaction of chitosan with any of these acids are suitable for use herein.

Examples of chitosan salts formed with an inorganic acid include, but are not limited to, chitosan hydrochloride, chitosan hydrobromide, chitosan phosphate, chitosan sulphonate, chitosan chlorosulphonate, chitosan chloroacetate and mixtures thereof. Examples of chitosan salts formed with an organic acid include, but are not limited to, chitosan formate, chitosan acetate, chitosan lactate, chitosan glycolate, chitosan malonate, chitosan epoxysuccinate, chitosan benzoate, chitosan adipate, chitosan citrate, chitosan salicylate, chitosan propionate, chitosan nitrilotriacetate, chitosan itaconate, chitosan hydroxyacetate, chitosan butyrate, chitosan isobutyrate, chitosan acrylate and mixtures thereof. It is also suitable to form a chitosan salt using a mixture of acids including, for example, both inorganic and organic acids.

Highly preferred water-soluble chitosan salts for use herein are those formed by the reaction of chitosan with an amino acid. Amino acids are molecules containing both an acidic and amino functional group. The use of amino acids is highly preferred as those chitosan amino salts have higher skin compatibility. Indeed most of the amino acids are naturally present on the skin. Chitosan salts of pyrrolidone carboxylic acid are effective moisturizing agents and are non-irritating to skin. Amino acids for use herein include both linear and/or cyclo amino acids. Examples of amino acids for use herein include, but are not limited to, alanine, valine, leucine, isoleucine, proline, phenylalanine, tryptophan, methionine, glycine, serine, cysteine, tyrosine, asparagine, glutamine, aspartic acid, glutamic acid, lysine, arginine, histidine, hydroxyproline and the like. A particularly suitable example of a cyclic amino acid is pyrrolidone carboxylic acid, which is a carboxylic acid of pyrrolidin-2-one as per following formula:



Other chitosan materials for use herein include cross-linked chitosans with a low degree of cross-linkage and modified chitosans. Suitable crosslinking agents for use herein are organic compounds having at least two functional groups or functionalities capable of reacting with active groups located on the chitosan materials. Examples of such active groups include, but are not limited to, carboxylic acid (-COOH), amino (-NH<sub>2</sub>), or hydroxyl (-OH) groups. Examples of such suitable crosslinking agents include, but are not limited to, diamines, polyamines, diols, polyols, dicarboxylic acids, polycarboxylic acids, aminocarboxylic acids, aminopolycarboxylic acids, polyoxides and the like. One way to introduce a crosslinking agent with the chitosan material solution is to mix the crosslinking agent with chitosan during preparation of the solution. Another suitable crosslinking agent comprises a metal ion with more than two positive charges, such as Ca<sup>2+</sup>, Al<sup>3+</sup>, Fe<sup>3+</sup>, Ce<sup>3+</sup>, Ce<sup>4+</sup>, Ti<sup>4+</sup>, Zr<sup>4+</sup> and Cr<sup>3+</sup>. Since the cations on chitosan possess antimicrobial properties, it is preferred herein to not use a crosslinking agent reacting to the cations, unless no alternative crosslinking agent is available.

Modified chitosans for use herein are any chitosans where the glucan chains carry pendant groups. Examples of such modified chitosans include carboxymethyl chitosan, methyl pyrrolidinone chitosan, glycol chitosan and the like. Methyl pyrrolidone chitosan is for instance described in US 5,378,472. Water-soluble glycol chitosan and carboxymethyl chitosan are for instance described in WO 87/07618. Particularly suitable modified chitosans for use herein include water soluble covalently bonded chitosan derivatives or ionically bonded chitosan derivatives obtained by contacting salt of chitosan with electrophilic organic reagents. Such water-soluble chitosan derivatives are described in EP-A-737,692. Examples of chitosan derivatives suitable for use herein are described in depth in EP-A-737,692.

According to the present invention the particularly preferred chitosan materials are substantially water-soluble salts. Usually, the water-solubility of the chitosan salts as used herein can be

improved by changing the pH of the solvent. The preferred chitosan salts for use herein, chitosan pyrrolidone carboxylate and chitosan lactate, have a higher water-solubility at acidic pH. Typically, the requirement of water-solubility for the preferred chitosan salts for use herein excludes chitosan salts with a substantial amount of cross-linking.

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The preferred substantially water-soluble chitosan salts are commercially available from numerous vendors. Exemplary of a commercially available water-soluble chitosan salts are those available from for example the Vanson Company. The preferred chitosan salt for use herein is chitosan pyrrolidone carboxylate (also called chitosonium pyrrolidone carboxylate), which has a  
10 degree of deacetylation of more than 85%, a water solubility of 1% (1 gram is soluble in 100 grams of distilled water at 25°C and one atmosphere) and a pH of about 5. Chitosonium pyrrolidone carboxylate is commercially available under the name Kytamer® PC from Amerchol Corporation. Another particularly preferred chitosan salt for use herein is chitosan lactate, the  
15 chitosan salt of lactic acid, which is commercially available from Vanson Company, Redmond, WA, USA. It is also within the scope of the present invention to use mixtures of different substantially water-soluble chitosan salts.

By 'particles' as used herein refers to discrete flakes, fibres, beads and the like or mixtures thereof, of chitosan material. The term 'particles' herein also includes agglomerations or  
20 aggregations of discrete flakes, fibres, beads and the like of a certain material. 'Particle size' as used herein means the weighted average of the smallest dimension of the individual particles.

'Region with particles of chitosan material' or 'region with particles of a substantially water-soluble chitosan salt' as used herein refers to any area located on or within the absorbent  
25 member, which comprises at least one particle of a chitosan material and preferably more. It is understood herein that such regions can comprise a fraction of the total absorbent member or might comprise the total absorbent member per se. For example in absorbent articles, especially those for feminine protection like sanitary napkins or panty liners, such absorbent members can be used as absorbent cores or as secondary topsheets or secondary backsheets. It is possible that  
30 the absorbent member comprises chitosan material only in the so-called central region, i.e., a region where body fluids like menstruation is discharged in use, and/or in longitudinal and/or lateral zones, i.e. on the peripheral edges of the absorbent articles, where run-off leakage of liquid needs to be prevented. Said region can have any size or shape. Such a region can be substantially coextensive with one or both of the surfaces of the absorbent member or can be coextensive to

only a part of one or both of said surfaces. Said region can have an regular or irregular shape, including but not limited to, dots, squares, circles, ellipses, continuous or discontinuous stripes, and so on.

5 One reason for the outstanding leakage prevention benefits associated to the present invention is the presence of the chitosan material in fine particulate form. Because of the small particles of chitosan material used herein, as defined by the selected particle size, the active surface area is very high compared to bigger particles for a same total weight. This contributes to the improved activity towards fluid gelation according to the present invention. Advantageously, due to the  
10 high active surface area of the small chitosan material particles according to the present invention, the gelification and retention properties of chitosan material towards electrolyte-containing fluids are improved and hence the leakage prevention is significantly improved, this while using significantly less total amount of chitosan material.

15 Furthermore, due to the water-solubility of the preferred substantially water-soluble chitosan salts used herein the gelation capabilities are further enhanced. The reason is that such chitosan materials are able to dissolve in the fluids to be gelified, such as menses, and thus can interact with all components of those fluids much more intensely compared to non-soluble chitosan materials, which gelify fluids by only surface interference.

20 By the water-solubility of the preferred chitosan compounds for use herein also other benefits provided by chitosan material are enhanced, such as the reduction of malodours originating from body fluids or the decrease of microbial activity.

25 Typically, a region with particles of chitosan material as defined herein comprises particles of chitosan material at a level of from  $0.1 \text{ g/m}^2$  to  $200 \text{ g/m}^2$ , preferably from 1 to  $100 \text{ g/m}^2$ , and more preferably from 2 to  $50 \text{ g/m}^2$  of said absorbent member.

30 According to a preferred embodiment of the present invention at least 40%, preferably 60%, more preferably 80% and most preferably 100% of at least one surface of said absorbent member is covered by regions with particles of chitosan material.

The regions with particles of chitosan material, particularly substantially water-soluble chitosan salt, of the absorbent member according to the present invention comprise particles of chitosan

material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$ . Preferably these particles have a particle size distribution with a mean diameter  $D(v,0.9)$  of from 10 nm to 300  $\mu\text{m}$ , preferably from 10 nm to 100  $\mu\text{m}$  and more preferably from 10 nm to 50  $\mu\text{m}$ ; it is particularly preferred that said regions comprise so-called 'nanoparticles' of chitosan material. According to the present invention, such nanoparticles have a particle size distribution with a means diameter of less than 1  $\mu\text{m}$ , preferably from 10 to 800 nm and more preferably from 20 to 500 nm. By 'mean diameter  $D(v,x)$  of less than  $y \mu\text{m}$ ' for a particle size distribution it is meant that  $(x*10)\%$  of the particles have a mean diameter of less than  $y \mu\text{m}$ . For instance, a  $D(v,0.9)$  of not more than 100  $\mu\text{m}$  indicates that 90% of the particles of chitosan material have a mean diameter of not more than 100  $\mu\text{m}$ . The particle size distribution has been determined by the method as disclosed herein.

It is to be understood herein that any method known in the art to provide an absorbent member with a region with particles of chitosan material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  is suitable to be used herein. Particularly preferred are methods, which are able to provide nanoparticles of chitosan material, having the properties as disclosed infra, onto the absorbent member. This includes spraying processes, curtain coating, printing and slot coating processes. Highly preferred herein is to use a spraying process as described in more details hereinafter in the process for making a preferred absorbent member according to the present invention.

The absorbent member according to the present invention can comprise further optional components. In a preferred embodiment, the absorbent member according to the present invention might comprise a latex binder. Typically, the absorbent member according to the present invention comprises from 1 to 30  $\text{g/m}^2$ , preferably from 1 to 20  $\text{g/m}^2$  and more preferably from 1 to 10  $\text{g/m}^2$  of said absorbent member of latex.

In a particularly preferred embodiment, the absorbent member further contains particulate superabsorbent polymeric material, such as anionic superabsorbent material like absorbent gelling material based on polyacrylates. The superabsorbent polymeric material suitable for use herein can be in the form of fibres or of powder. Typically, the absorbent member according to the present invention comprises from 5 to 300  $\text{g/m}^2$ , preferably from 20 to 150  $\text{g/m}^2$ , and more preferably from 30 to 75  $\text{g/m}^2$  of said absorbent member of particulate superabsorbent material.

Another class of compounds to be optionally comprised by the absorbent member of the present invention are odour control compounds. In particular, the absorbent member of the present invention can comprise silica, zeolites, pH-adjusting material, chelants like EDTA, metal ions, cyclodextrins, urease inhibitors, antimicrobial compounds, activated carbon and mixtures thereof.

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Process for producing an absorbent member according to the present invention

In its broadest embodiment, the present invention also comprises a process for making an absorbent member. The process is characterized by the essential steps of forming a precursor web, subsequently applying chitosan material onto at least one surface of the precursor web by a particular spray method and finally drying the resulting absorbent member.

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The term 'precursor web' as used herein refers to absorbent materials, which serve as the basis for making the absorbent member of the present invention. The precursor web for use herein typically has significant internal void space in the form of pores, holes, apertures, interstitial space between fibres and the like. Examples of precursor webs for use in the present invention are fibrous structures, such as nonwovens or fabrics, comprising natural or synthetic fibres or mixtures thereof, or apertured polymeric films or foam materials. Indeed, the precursor web for use in the present invention can be made of any of a variety of fibres, including a blend or admixture. The fibres may be cellulosic, modified cellulosic, or hydrophilic synthetic and include such fibres as wood pulp, rayon, cotton, cellulose acetate, polyester, nylon and the like. The precursor web can be made according to any suitable method known for this purpose in the art. Fibrous precursor webs according to the present invention can be made by appropriate processes such as dry laying and in particular air laying, melt blowing or spunbonding. Film-like or foam-like precursor webs according to the present invention are made by processes suitable for such purposes.

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Highly preferred precursor webs for use herein are hydrophilic fibrous webs. As used herein, 'hydrophilic' refers to a material having a contact angle of water in air of less than 90 degrees, whereas the term 'hydrophobic' herein refers to a material having a contact angle of water in air of 90 degrees or greater. A precursor web comprising hydrophilic fibres like for example cellulosic fibres such as wood pulp fibres is particularly useful as an precursor web in such products as sanitary napkins, disposable diapers or wipes because the hydrophilic fibres are liquid absorbent and therefore enhance the overall absorbency of the precursor web. Preferably,

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precursor webs for use herein can be made of a blend of cellulosic and hydrophilic synthetic fibres, typically comprising about 65% to 95% by weight of cellulosic fibres and more preferably up to about 20% by weight of the hydrophilic synthetic fibres. The hydrophilic synthetic fibres, which can be provided in any length including staple length, can improve the strength of the precursor web. Hydrophobic fibres or films, such as fibres or films made of polyethylene or polypropylene, may also be used in the precursor web herein provided they are treated by e.g. surfactants to make them hydrophilic, in order not to decrease the absorbent capacity of the preferred absorbent member, when incorporating them into said precursor web.

In a preferred embodiment the precursor web for use herein is a dry laid, preferably an air laid fibrous web. 'Dry laying' and more specifically, 'air laying' processes are widely used to produce webs from dry fibres, which can in turn be used e.g. as webs for absorbing fluids. Particularly, dry laying refers to e.g. carding or air laying. Carding refers to the formation of carded precursor webs, i.e. precursor webs in which the fibres are oriented (carded) in a given direction, whereas the air laying process refers to the formation of precursor webs with a completely random fibre orientation; the properties of such air laid precursor webs are therefore somewhat isotropic. The precursor webs produced by dry laying processes are soft, flexible and porous and are particularly suitable for use as liquid precursor webs in absorbent articles, such as disposable diapers, sanitary napkins, incontinent pads and wipes.

The dry laid manufacturing process generally comprises a web formation and layering step and a web bonding and stabilizing step; in dry laying processes in fact the fibres, that can be of any type, e.g. cellulosic, synthetic, or any combination thereof, are formed or condensed into a web, but such web lacks integrity and must therefore be stabilized. Different techniques for bonding and stabilizing a dry formed web are known in the art, i.e. mechanical, thermal and chemical bonding processes. Bonding a web structure by means of a chemical agent is one of the most common methods of bonding in the nonwoven industry and consists in the application of a chemical binder to the web and in the curing of the binder.

Indeed, in the process according to the present invention the chitosan material, preferably substantially water-soluble chitosan salt, is applied onto the precursor web as a solution or dispersion in the form of a spray of droplets having a droplet size distribution with a mean diameter  $D(v,0.9)$  of not more than 1500  $\mu\text{m}$ , the amount of chitosan material solution or

dispersion applied onto the precursor web being preferably from 1 ml to 1000 ml per square meter of said precursor web.

5 It has now been found that by applying the solution or dispersion of chitosan material on an precursor web in the form of a spray of droplets having a droplet size distribution with a mean diameter  $D(v,0.9)$  of not more than 1500  $\mu\text{m}$ , preferably not more than 1000  $\mu\text{m}$ , more preferably not more than 750  $\mu\text{m}$ , a region with particles of chitosan material, preferably substantially water-soluble chitosan salt, having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  is provided on the precursor web, which translates in excellent fluid  
10 handling and gelifying performance, namely towards electrolyte-containing fluids, while requiring less chitosan material. Indeed, by applying the chitosan material solution or dispersion onto the precursor web in the form of a spray of small droplets as defined herein, a higher coverage of the sprayed surface is achieved, as compared to applying the same chitosan material solution or dispersion but in the form of a spray of larger droplets. Furthermore, applying the  
15 solution or dispersion of chitosan material on the precursor web as mentioned herein, translates into limited wetting of the surface, and thus in faster drying of the solution or dispersion of chitosan material. In other words, a region with particles of a substantially water-soluble chitosan material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  is generated in less time, resulting in improved processability and hence reduced process  
20 costs. A further benefit of applying the solution or dispersion defined infra as spray of small droplets is that the depth of penetration of said solution or dispersion is lower than the one of a spray of larger droplets. The advantage is that the precursor web is less wetted in its depth, which reduces the time for drying of said structure after the chitosan application.

25 It is particularly preferred herein to create a region comprising nanoparticles as defined infra of chitosan materials on the precursor web.

By 'mean diameter  $D(v,x)$  of not more than  $y \mu\text{m}$ ' for a droplet size distribution it is meant that  $(x*10)\%$  of the spray of droplets dispensed (expressed in volume unit) has a mean droplet  
30 diameter of not more than  $y \mu\text{m}$ . For instance, a  $D(v,0.9)$  of not more than 1500  $\mu\text{m}$  indicates that 90% of the total sprayed volume is dispensed with droplets whose mean diameter is not more than 1500  $\mu\text{m}$ . The droplet size distribution has been determined by the test method disclosed herein.

Any apparatus adapted to deliver a spray of droplets as defined herein are suitable for use herein. Several modifications can be made to the conventional, single aperture, spray head to ensure that a spray of such droplets as required herein is formed. Suitable apparatuses to be used herein (also called spray dispensers) share the common feature of having at least one aperture or a plurality of apertures also called "dispensing openings" or "spray nozzles" through which the solution/dispersion of the chitosan material is dispensed already mixed with air, said apertures being configured so as to deliver a spray of droplets having the characteristics mentioned herein. Suitable apparatus for use herein are air atomizers or nebulizers, which may be electrically operated.

According to the above-described spraying procedure a substantially homogeneous pattern of chitosan material particles is typically provided on the precursor web, in which after drying a region with particles of a substantially water-soluble chitosan material, preferably substantially water-soluble chitosan salt, having a particle size distribution with a mean diameter  $D(v,0.9)$  of from 10 nm to 300  $\mu\text{m}$ , preferably from 10 nm to 100  $\mu\text{m}$ , more preferably from 10 nm to 50  $\mu\text{m}$ , even more preferably from 10 to 800 nm and most preferably from 20 to 500 nm.

In its most generic form, the process for making an absorbent member according to the present invention comprises the steps of:

- (a) forming a precursor web having a first and a second surface, said second surface being approximately aligned opposite to said first surface, and
- (b) applying during process step (a) onto at least one surface of said precursor web a solution or dispersion comprising chitosan material, and/or
- (b') applying after process step (a) onto at least one surface of said precursor web a solution or dispersion comprising chitosan material, said solution or dispersion is applied onto said precursor web in the form of a spray of droplets as described herein, and
- (c) drying said precursor web, whereby forming at least one region with particles of chitosan material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  on said surface of said precursor web on which said solution or dispersion of chitosan material was applied in steps (b) and/or (b').

In a preferred embodiment herein, the process comprises subsequently to step (a) the additional steps of applying latex onto at least one surface of said precursor web and drying said precursor web. After the drying, step (b') follows. Step (b) is not carried out in this embodiment.

- 5     Optionally, in cases where regions with particles of chitosan material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  are required between the surfaces of the absorbent member of the present invention, an additional step (d) can be carried out after step (c). This additional step (d) is a second web forming process onto the surface of the precursor web, where the solution or dispersion of chitosan material was applied. This results in  
10    an absorbent member with at least one said region inside of it, i.e. between its surfaces. The second web forming step (d) can either be equal to the initial step (a) of forming the precursor web or different, which would result in a region with particles of chitosan material having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  being located in a relatively homogeneous absorbent member or in an inhomogeneous absorbent member  
15    comprising two different web layers. However, similar structures can be achieved by placing a second already-formed web on said surface of the precursor web, where the solution or dispersion of chitosan material was applied.

- Several methods are known for applying latex binder to the precursor web, while spray bonding  
20    and print bonding are particularly preferred herein. The 'latex' is usually an aqueous dispersion of a polymeric component and can be applied to a surface of the precursor web. Preferably, the polymeric component of the aqueous latex for use in the present invention substantially consists of hydrophilic material.

- 25    The latex is applied as an aqueous emulsion or dispersion, which typically contains about 5 to 65% and preferably, 10% of solids. These latex materials are readily available from several manufacturers. Because the latex dispersions are water miscible, they may be further diluted, if desired, before being applied to the precursor web. In addition, these latex compositions are thermosetting and in order to effect cross-linking, they can contain a small amount of suitable  
30    cross-linking agents which are well known chemical agents for this purpose, such as N-methylolacrylamide. Any type of latex known in the art can be used herein, if the polymeric component is substantially hydrophilic and the latex does not generate detectable odours, especially after curing, which would be unacceptable to the wearer. Latices available are classified by chemical family and those particularly useful herein include vinyl acetate and

- acrylic ester copolymers, ethylene vinyl acetate copolymers, styrene butadiene carboxylate copolymers and polyacrylonitriles and sold, for example, under the trade names of Airbond, Airflex and Vinac of Air Products, Inc., Hycar and Geon of Goodrich Chemical Co. and Fulatex of H. B. Fuller Company. A particularly preferred example of latex suitable for use in the present invention is Airflex 192, obtainable from Air Products and Chemicals Inc., Allentown, PA, USA. The amount of latex used in the absorbent member of the present invention cannot be so high as to substantially impair or obscure the effective gelification capacity of the chitosan material and the absorbent properties of the hydrophilic fibres, or as to impart a degree of stiffness to the absorbent member as to render it impractical. The latex is applied onto the surface of the precursor web at a loading of from about 1 to 30 g/m<sup>2</sup>, preferably from about 1 to 20 g/m<sup>2</sup> and more preferably from 1 to 10 g/m<sup>2</sup> of the precursor web. Latex with substantially hydrophobic polymeric components can also be used in the present invention by rendering them hydrophilic after their application onto the precursor web, e.g. by surfactants.
- The presence of latex underlying the particles of chitosan material as used herein has the advantage of contributing to the control of the penetration of said particles into the precursor web to which they have been applied. Preferably, the particles of chitosan material do not penetrate into more than 30%, preferably not more than 20% and more preferably not more than 10% of the calliper of the precursor web. Because of this, the application of latex in the process of the present invention allows the production of particularly preferred absorbent members of the present invention that are even more effective in leakage prevention towards fluid while more efficiently using the chitosan material on the surface of the precursor web to which it is applied to. Indeed, it is speculated without wishing to be bound by theory that the application of latex provides a coating on the surface of the precursor web that reduces the depth of penetration of the solution or dispersion of chitosan material into the precursor web by partially sealing apertures, interfibre space and the like on said surface. The depth of penetration can easily be measured by cutting the absorbent member through its thickness and taking a picture of the cross-section of the cut absorbent under the microscope and subsequent evaluation of said picture.
- In the following, an exemplary process is described for making the absorbent member of the present invention. It should be understood that the process as described hereinafter is not limiting the scope of the present invention. It is outlined that the precursor web for use with the present invention can be made using conventional equipment designed for dry laying processes, although the following process is described with particular reference to air laid webs. It should be

understood that other dry laying processes, e.g. carding, or other processes for creating fibrous substrates, such as the meltblown process or the spunbond process, or film forming or foaming are also applicable. It is also to be noted that besides the fact that in the following process the use of latex is described, this feature is optional and in no way limiting the scope of the present invention. The following reference numerals refer to Figure 1.

In accordance with a preferred embodiment of the present invention, the precursor web is made by an air laid process. The air forming system includes a distributor unit (1) disposed transversely above a continuous forming screen (3) mounted on rollers and driven by a suitable motor (not shown) and a vacuum means or suction box (2) is positioned beneath the screen (3). In a conventional air forming system, upstream of the distributor unit is a defibrator or feeder (not shown), such as a hammer mill or Rando-Feeder, where bales, laps or the like are defiberized and further the fibres may be cleaned and/or blended if necessary or desired depending largely on the type of fibres used, the blend of fibres used and the end product sought. For example, wood pulp fibres can be blended with substantially hydrophilic synthetic fibres and applied as a blend by a single distributor, or different fibres can be each conveyed by a different distributor to the screen to form separate plies or layers.

The porous forming screen (3) is essentially coextensive with the distributors (1), and the suction box (2) beneath the screen (3) draws the air stream downwardly and conveys the fibres to the surface of the screen (3), thereby forming a loose precursor web. At this stage of the process, the precursor web exhibits little integrity and the vacuum means (2) retains the loose, fibrous precursor web on the screen (3). The precursor web has a first surface that faces the distributor (1) and a second surface, opposite to said first surface, which faces the forming screen (3).

It should be understood that the system might be modified to control the composition and thickness of the final absorbent member. For example, the distributor unit (1) can comprise a plurality of individual distributors and this number of distributors as well as their particular arrangement can be altered or varied depending on factors like machine speed, capacity, type of fibres and desired end product.

At this stage of the process, the precursor web on the screen (3) requires stabilization. The precursor web is advanced by the continuous screen and if desired, the precursor web first may be passed between compression rollers (not shown), which may be heated in order to increase the

density of the precursor web, but this step is optional. This densification step also enhances the penetration of the latex, which is applied subsequently onto the precursor web and the degree or percentage of densification can vary depending on such factors like the basis weight of the precursor web, the desired degree of penetration of the latex into the precursor web and the  
5 desired end product.

From there, the precursor web is transported to the first latex application section (4) having a suitable dispensing means, such as a spray nozzle, doctor blade, roller applicator, or the like, where a liquid dispersion of the latex binder is applied to the first surface of the loose precursor  
10 web. Optionally, a vacuum applied by a suction box (5) positioned beneath the dispensing means and the screen helps to draw the latex dispersion into the precursor web. The dispensing means or applicator is essentially coextensive with the width of the precursor web and preferably, the latex is applied substantially homogeneously to the surface of the precursor web. However, the latex dispersion may be applied as a non-uniform or random application and because the latex  
15 dispersion is water-based, it will diffuse throughout the precursor web and function as a binder when cured.

The latex when cured imparts integrity to the precursor web and therefore some penetration of the latex is required. The extent or degree of penetration of the latex into the precursor web is  
20 controlled by the amount of latex applied and optionally by the vacuum applied to the precursor web in that the vacuum helps to draw the latex dispersion into the precursor web. The polymeric component of the latex is a substantially hydrophilic thermosetting plastic and in order to activate it, the latex dispersion can contain a suitable curing agent or cross-linking agent and after the latex is applied onto the precursor web, the latex is cured to effect cross-linking. In a particularly  
25 preferred embodiment, curing of the latex is accomplished by passing the latex-treated precursor web after the first latex application section (4) through a first drying section (6), e.g. a hot air oven or an air drier. The temperature inside of the first drying section typically ranges from about 100 °C to 260 °C, but this depends upon the specific type of latex resin used, upon the curing agent or cross-linking agent, upon the amount of latex, the thickness of the precursor web, the  
30 degree of vacuum and the machine speed. It is essential for the described process that the first surface of the latex-treated precursor web is substantially dry after the first drying section (6).

After the first drying section (6), the precursor web is being sprayed with the solution or dispersion of chitosan material, preferably substantially water-soluble chitosan salt, (preferably

4% by weight of chitosan material in water) onto the same surface, onto which latex was applied before in the chitosan application section (7). According to the present invention, the solution or dispersion of the chitosan material is applied on the precursor web in the form of a spray of droplets having a droplet size distribution with a mean diameter  $D(v,0.9)$  of not more than 1500  $\mu\text{m}$ . The amount of chitosan material solution or dispersion applied onto the precursor web is preferably from 1 ml to 1000 ml, more preferably from 1 ml to 400 ml and most preferably about 120 ml of solution or dispersion of chitosan material per square meter of precursor web. For achieving the above-mentioned particle size distribution of said spray, it is particularly preferred to use so-called air atomizers or nebulizers for applying the solution of the chitosan material onto the surface of the precursor web. Examples therefore are the air atomising nozzles of the ¼ JAU series from Spraying Systems, Co., Wheaton, Illinois, USA. By such a spray process, after drying chitosan material particles having a particle size distribution with a mean diameter  $D(v,0.9)$  of not more than 300  $\mu\text{m}$  are generated on the surface of the precursor web, which was sprayed with the solution or dispersion of the chitosan material. Preferably, said particles have a particle size distribution with a mean diameter  $D(v,0.9)$  of from 10 nm to 300  $\mu\text{m}$ , preferably from 10 nm to 100  $\mu\text{m}$ , more preferably from 10 nm to 50  $\mu\text{m}$ , even more preferably from 10 to 800 nm and most preferably from 20 to 500 nm.

It is preferred to also apply latex to the second surface of the precursor web as well. Therefore, the precursor web is preferably reverted. After the reversion step, latex is applied onto the second surface of the precursor web by the second latex application section (8) in essentially the same way as the first surface in the first latex application section (4). In addition, the second latex application section (8) can include a suction box (9) for controlling the penetration of the latex into the precursor web. This second latex application is likewise cured by passing the precursor web through a second drying section (10) subsequent to the second latex application section (8) within about the same temperature range as indicated at the first drying section (6).

The absorbent member resulting from the above process passes, after having left the second drying section (10), a subsequent third drying section (11) for removing last traces of moisture within about the same temperature range as indicated at the first drying section (6). Afterwards the absorbent member exhibits sufficient integrity and can be cut, rolled, packaged, etc.

In an alternative embodiment, the chitosan material can be sprayed onto the second surface of the precursor web after the second drying section (10), instead onto the first surface after the first

drying section (6). For this purpose, the second surface of the precursor web has to be substantially dry after having passed the second drying section (10).

5 It is also within the scope of the present invention that the chitosan material is applied onto the first and/or second surface of the precursor web after the first (4) or the second (8) latex application sections, when the precursor web is still wet from the latex dispersion applied.

10 The concentration of the solution or dispersion of chitosan material to be applied onto the precursor web can vary from 0.1 to 40% by weight of chitosan material and is preferably from 1 to 10% by weight and more preferably 4% by weight of chitosan material. The pH of the solution or dispersion of chitosan material to be applied onto the precursor web is from 3 to 7, preferably from 4 to 6 and more preferably about 5 for an optimum match between skin-friendliness and water-solubility.

15 Notwithstanding the application of the latex, the absorbent member is soft yet strong and absorbent, exhibiting a relatively high tensile strength. It is desirable for preferred absorbent members of this type to have relatively low bulk, because a more dense precursor web, when compared to similar absorbent members containing no latex and of about equal absorptive capacity but of higher bulk, can be thinner yet highly absorbent and consequently less bulky. A  
20 reduction in bulk, which means a reduction in volume the absorbent member is occupying, without sacrificing significantly other desired properties, is important from the standpoint of manufacturing, storage and packaging. Hence, for absorbent members of this invention the basis weight ranges from about 20 g/m<sup>2</sup> to 500 g/m<sup>2</sup>, preferably from about 75 g/m<sup>2</sup> to 400 g/m<sup>2</sup> and more preferably from 100 g/m<sup>2</sup> to 200 g/m<sup>2</sup>. There can be manufacturing constraints in producing  
25 an absorbent member having a basis weight lower than about 20 g/m<sup>2</sup> in that such an absorbent member may lack desired strength. When the basis weight exceeds the upper limit, the absorbent member may be too stiff and therefore not useful for most applications.

30 Absorbent members made according to the above-described process exhibit a good integrity due to the application of latex, combined with good liquid barrier capabilities. The depth of penetration of the latex binder into the precursor web is controlled by the choice of the polymer concentration and the amount of the latex to be applied onto the precursor web and optionally by the vacuum applied by means of the suction boxes positioned in correspondence with the dispensing means.

In an alternative embodiment of the absorbent member of the present invention a porous reinforcing sheet such as a creped paper, a tissue, or a nonwoven, can be incorporated into the precursor web either as a surface sheet or as an intermediate sheet disposed intermediate the first and second surfaces of the absorbent member. The sheet can be present on one surface of the absorbent member while the opposite surface bears cured latex.

In another embodiment the precursor web can comprise a layer of polyester or polyolefin nonwoven having a layer of air laid fibres on top. Bonding between the fibres of the two layers is achieved by means of mechanical entangling, while the latex binder is subsequently only applied to the surface of the precursor web which is opposite to the polyester or polyolefin layer.

As mentioned before, the use of a binder, such as latex, is optional in the process of the present invention. Therefore, the above-described embodiment of the process for making the absorbent member is in no way limiting the scope of the present invention.

### Examples

#### Example 1:

The absorbent member of the present invention is illustrated by the following example: The absorbent member comprises an airlaid precursor web made of 68% of cellulose fibres (NB 416 from Weyerhaeuser) mixed with 17% of polyacrylic superabsorbent powder (Acqualic L74 from Nippon Shokubai), 11% of synthetic fibres (T255 3DTEX-3mm from Trevira), and 4% of latex (Elite 33 from Vinamul) (2% per surface), which was applied via a spraying system onto both surfaces of the absorbent member. The particles of chitosan pyrrolidone carboxylate (Kytamer from Amerchol) were sprayed as a solution of 4% by weight of chitosan pyrrolidone carboxylate in water onto one side of the airlaid precursor web at a loading of 6 g of chitosan pyrrolidone carboxylate per square meter of the absorbent member after drying (Air atomising system from Spraying Systems Co, area coverage than of 90 %, droplet size distribution with a mean diameter  $D(v,0.9)$  of from 5 to 400 nm). The particle size distribution with a mean diameter  $D(v,0.9)$  of the particles of chitosan pyrrolidone carboxylate generated was from 20 to 100 nm after drying.

Example 2:

The absorbent member of the present invention is further illustrated by the following example: The absorbent member comprises an airlaid precursor web made of 68% of cellulose fibres (NB 416 from Weyerhaeuser) mixed with 17% of polyacrylic superabsorbent powder (Acqualic L74 from Nippon Shokubai), 11% of synthetic fibres (T255 3DTEX-3mm from Trevira), and 4% of latex (Elite 33 from Vinamul) (2% per surface), which was applied via a spraying system onto both surfaces of the absorbent member. Chitosan lactate (Chitosolv L from Vanson, Inc.) were sprayed as a solution of 6% by weight of chitosan lactate in water onto one side of the airlaid precursor web at a loading of 6 g of Chitosan Lactate per square meter of the absorbent member after drying (Air atomising system from Spraying Systems Co, area coverage than of 90 %, droplet size distribution with a mean diameter  $D(v,0.9)$  of from 5 to 400 nm). The particle size distribution with a mean diameter  $D(v,0.9)$  of the particles of chitosan pyrrolidone carboxylate generated was from 20 to 100 nm after drying.

Test methods1. Particle size distribution

The particle size distribution of the chitosan material can be determined by ESEM analysis, using a Philips XL30 ESEM FEG electronic microscope for example. A random sample of 1.5 cm x 1.5 cm was cut with a scissors from the part of the absorbent member comprising the region with particles chitosan material according to the present invention and mounted on a circular aluminium stub having a diameter of 1.2 cm. The sample was then sputtered with a layer of gold having a thickness of 30 nm. The sample was observed in SEM mode *in vacuo* at an appropriate magnification to visually investigate the particle size of the chitosan material, taking six images in different zones of the sample. The size of the individual particles is determined visually.

2. Droplet size distribution

The particle size distribution of a spray of droplets can be determined as follows: Suitable test equipment is for instance a Malvern Mastersizer S LongBed<sup>®</sup> with 1000 mm lens and a maximum particle size range of 3475  $\mu\text{m}$ . The Malvern Mastersizer S LongBed<sup>®</sup> provides 21 cm opening (between lenses) to accommodate spray flow. In all readings at the Malvern<sup>®</sup>, the lens surface

must remain free of spray contamination. In the present setup procedure, the distance from nozzle to laser was fixed at 8 cm to minimize lens contamination. At 8 cm distance, the spray was directed to the laser beam to place the laser centre to the spray cone. At least three readings have to be made for each sample of chitosan material solution/dispersion sprayed to determine the droplet size distribution of the spray of droplets. The sprayer used in this test was an electrically operated sprayer.